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forced to abandon the undertaking by pressure of other work, turned over his manuscript to Mr. Warren, who not only makes due acknowledgment for important aid in preparing the diagnoses and keys of the higher groups, and for other assistance, but dedicates the work to his helpful friend. The species and subspecies are briefly but clearly described, and their distribution is given in detail so far as it is known, following which, and printed in larger type, is a more or less extended biography. In the case of the rodents and other small mammals, the biographical matter is generally given under the leading member of the group (genus or species, as the case may be); since among closely allied forms there is no essential difference in habits.

The number of species and subspecies here recorded for Colorado is about 150. In the matter of nomenclature the authorities of the biological survey have evidently been followed.

In style of treatment and character of matter "The Mammals of Colorado" sets a good standard for similar works, and its usefulness will be appreciated far beyond the region with which it deals. It satisfactorily reflects present knowledge of the mammal fauna of Colorado, and forms a good basis for the addition of details at present unknown. Furthermore, it contains a vast amount of original information here published for the first time.

J. A. ALLEN

Researches on Fungi. By A. H. REGINALD BULLER. London, Longmans, Green and Co. 1909. 5 plates and 83 figures. Pp. xi + 287.

In this work the author gives the results of his intensive researches on the problems of the dispersal of spores of the Hymenomycetes and other related topics. The book is most satisfying. It gives a mass of new facts well arranged and carefully summarized, by chapter and as a whole, together with full descriptions accompanied by clear figures which show the accuracy of the method and its painstaking character. The experiments are ingenious and brought as far as possible to a conclusion.

Buller points out the admirable features of the sporophores of the agarics, such as the great increase in hymenial surface through the gills, the immense number of spores thus accommodated, together with the economy in the introduction of the shorter gills. The adhesive spores are spaced by the paraphyses and each one has unobstructed access to the open air. The stipe is advantageously placed, commonly central, is often a hollow tube following the well-known engineering structure. It is rigid through longitudinal tensions, holding a cap generally set at a position of stable equilibrium. The annulus serves as a foil in preventing insects from climbing to the unripe gills, yet does not interfere with the spore currents.

In certain chapters which might be said to have a philosophical trend, the phyletic value of the color of spores is considered; anemophily is compared with coprophily and the general problem of the arrangement of the group is touched upon. In this last the author opposes the views of Massee, who holds the Coprini to be primitive.

To the increasing amount of work that is being done on the tropic and morphogenic responses of the mushrooms, the researches of Buller make a distinct addition. His work on *Lentinus lepideus* has been previously published¹ but he reviews the main conclusions. He continues his experiments with the mushroom, with coprins and some polyporoids. The mushroom shows no light reaction, geotropism alone being effective. With *Polyporus squamosus* light is morphogenic but not directive, since the pilei do not develop without light, but their growth is not directed toward it. Gravity plays a part in the final adjustments. With coprins interesting pendulum-like physiological swingings—a parallel to the responses of phanerogam shoots—were obtained by tilting. In the coprins, generally, heliotropic responses were found; this seems to be a necessary consequence of the peculiarly irregular substratum, enabling the sporophores to avoid obstacles. This coupled with the rhythm in development insures the

¹ *Annals of Botany*, 1905, XIX., 427-438.

stretching of the stipe at times when light can be used as a directive influence.

One of the most interesting discoveries recorded in the book is that with reference to the ejection of the spores from the sterigmata. It is found that the spores may be expelled ten to thirteen times their own length and that they fall from the gills in a peculiar curve that Buller calls "sporabola." The emission of a powder from polyporoids had been seen before, but as a very rare occurrence. It has remained for Buller to devise by means of a beam of light a method of determining readily whether spores are being discharged or not. Then by observing some mature spores on a section of a gill, he was able to determine that the spores were actually projected, although the actual flight through the air could not be seen. This ejection is independent of hygroscopic conditions, takes place but slowly at 0°, and is stopped by anesthetics and by lack of oxygen. It is therefore a phenomenon of protoplasmic activity, not a mere result of hygroscopic tension.

For the Basidiomycetes the hypothesis is advanced that the discharge of spores is similar to the jerking process described for *Empusa* by Nowakowski. It involves the mutual bulging of the walls of the sporidia and the sterigmata, in opposite directions.

On the side of physics, Buller pushes the matter to a fine point, determining the specific gravity of spores by floating them in different strengths of CaCl_2 (allowing for plasmolysis) and also determining the rate of fall in the air. The latter was an attempt to verify Stokes's law on the fall of microscopic bodies. The results show a velocity 50 per cent. greater than the computed rate.

In Part II., the spore dispersal of the Ascomycetes is considered. Here the observations of the author lead him to conclude that the explanation of deBary which attributes the expulsion of spores to mere loss of water does not explain the phenomenon of "puffing." In general Buller is led to believe that the "puffing" is caused by a stimulus given to the protoplasm in contact with the ascus lid.

Some of the interesting points in the book

are: (1) The descriptions of the new Poynting's Plate Micrometer, (2) the figures on the increase of hymenial surface due to gills, (3) the number of spores per sporophore, (4) the specific gravity of various spores, (5) the effect of electric charges on different spores, (6) the persistence of vitality in certain xerophytic species, (7) the summary showing the present status of the work on the nuclear phenomena in the Basidiomycetes and (8) the problems suggested with reference to the relation of insects and spores.

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Experimentelle Untersuchungen über Atomgewichte. Von Th. W. Richards und seinen Mitarbeitern 1887-1908. Deutsche Ausgabe von J. KOPPEL. Pp. viii + 890. Hamburg und Leipzig, L. Voss. 1909. Preis M. 35.

Theodore William Richards occupies in our time, with regard to the precise determination of atomic weights, the place which was occupied in the first half of the past century by Berzelius and in the second half by Stas. And just as Stas, in his memorable investigation of the atomic weight of carbon, carried out jointly with Dumas, demonstrated the necessity of a new and independent study of the entire problem by his discovery of a not inconsiderable error in the atomic weight found by Berzelius, so Richards proved the necessity of his own researches by demonstrating the inexactness of Stas's fundamental value for silver. However, there is also a deep-seated difference between the two achievements: the older discovery was made at the beginning of the new period, and was exploited by Dumas in his usual highly dramatic fashion; while Richards was almost forced, by a series of mutually corroborating deviations, to abandon the older value, at first regarded by him with complete confidence, and to accept his own unexpected result. This says: Dumas was a thinker of the romantic type, while Richards is a classic, just as Berzelius and Stas were classics. Indeed, atomic weights can be successfully determined only by a classic. Witness Dumas, who undertook it in